Neutral Current Background in SNO in the Presence of the Neutral Current Detector Array

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The neutral current (NC) channel in the SNO detector:

$$\nu_x + d \rightarrow n + p + \nu_x. \tag{1}$$

can measure the total flux of all active flavors of neutrinos originating from the Sun. One of the NC detection methods in SNO is to deploy the Neutral Current Detector (NCD) array consisting 96 strings of ^{3}He proportional counters in a 1-m square lattice. Several $\beta - \gamma$ decay branches of ^{208}Tl and ^{214}Bi in the natural Th and U chains would generate γ's of energy greater than the deuteron binding energy of 2.2 MeV. These γ's can photodisintegrate the deuteron, and the resulting neutron can be confused with the NC signal in Reaction 1 above. Although the NCD's are constructed out of ultra-clean material, the NC background level in the heavy water will nonetheless increase in the presence of the array. Work has been performed to understand the neutral current (NC) background in the SNO detector.

The plots in Figure 1 show the xy-plane projected distance squared (R^2_{xy}) from the fitted event vertex to the center of the closest NCD. A plot of R^2_{xy} should be flat for uniformly distributed background in the D$_2$O and that for intrinsic NCD background should have a slope because of the grid deployment pattern of the NCD array. The difference in slope in these two distributions was exploited to determine the relative background contributions from the NCDs and the heavy water. The statistical uncertainties associated with the extracted NCD background levels are large. This is because the intrinsic radioactivity level of the D$_2$O, from which the NCD background level is extracted, is higher than the NCD intrinsic background. Analyses with different fiducial volume cuts show very little, if any, improvement to the statistical significance of the extracted NCD background.

We investigated whether a pattern recognition technique can be applied to the intrinsic backgrounds in the NCD body. This technique [1] uses the difference in light isotropy to distinguish ^{208}Tl decays from ^{214}Bi decays. We found that because most of the β's are stopped in the bulk of the NCD body, only the photodisintegrating γ's escape and generate signals in the SNO detector. Therefore it is not possible to distinguish ^{208}Tl decays from ^{214}Bi decays in the NCD body without the presence of the β's. However, the light absorption and scattering by the NCD body do not affect the ability to distinguish these two types of decays in the heavy water.

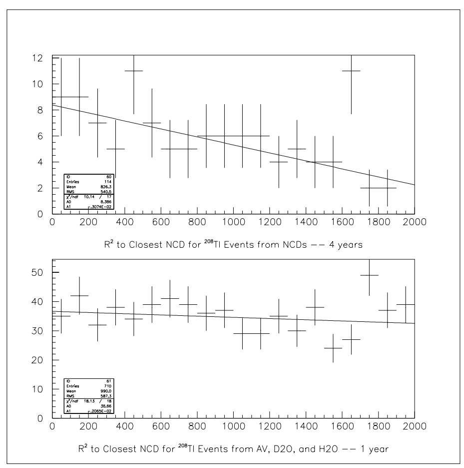

Figure 1: R^2_{xy} for ^{208}Tl $\beta - \gamma$ events. Top: Intrinsic NCD background; Bottom: Intrinsic D$_2$O background.

Footnotes and References

[1] X. Chen, D. Phil thesis, University of Oxford (1997)